U.S. Department of Housing and Urban Development • U.S. Department of Energy

# CHP Project Profiles in Multifamily Housing

Combined heat and power (CHP) systems are onsite energy systems that make both electricity and usable heat for buildings. This heat, recovered from the power generator, often can heat, cool, or dehumidify building space for much greater energy efficiency and lower cost than conventional systems. Multifamily housing may be ideal for CHP by using packaged systems for commercial-scaled projects, or by realizing economies-of-scale by using industrial or district energy-scaled equipment to meet demand from larger projects.

The U.S. Department of Housing and Urban Development (HUD) has established an Energy Action Plan to promote the President's National Energy Policy. One action is to further CHP in public housing and privately owned assisted housing, as well as in the redevelopment of brownfields. As part of that effort, HUD and the U.S. Department of Energy (DOE) are developing the CHP Project Profiles in Multifamily Housing series. Through straightforward assessments of CHP projects in public and assisted housing, these profiles are designed to encourage increased use of CHP in other HUD housing projects.

## Summit Plaza Complex: HUD-Assisted Housing | Jersey City, NJ

### Project History

In 1974, HUD launched the "total energy" initiative to demonstrate that CHP systems could provide power, heating, and cooling to HUD multifamily properties more efficiently than other systems, and also reduce imported resources. The CHP concept—called Modular Integrated Utility Systems at that time—was applied to Summit Plaza, a six-acre complex in Jersey City, as part of Operation Breakthrough. This ambitious project had the goal of developing and demonstrating major innovations in the field of industrialized building techniques for use by the housing industry.

The Summit Plaza CHP plant provides power, heating, and cooling to four residential towers with 485 units; a local public grade school with a heated pool; trash collection; and a commercial property. The Summit Plaza design is unique because HUD designed the entire complex to take optimal advantage of the CHP system. The design, installation, and operation of the system were studied and monitored by the National Bureau of Standards (NBS) for five years.

### CHP System Description and Analysis

Five 600-kW reciprocating engines provide a total of 3 MW of electricity generation potential, but typically only three are online, allowing for redundancy and guaranteed uptime during engine maintenance. The engines were built to run on #2 fuel oil; one engine has recently been retrofitted to run on natural gas.

The engines' gross electrical efficiency from November 1975 to October 1976 was 32.4%; gross electrical plus thermal efficiency was 61.4%[1]; while power reliability was 99.8%. Unplanned outages were mostly due to malfunctions in the plant's electrical control system.[2]

The original Utility Demonstration Agreement specified that the Summit Plaza property stay connected to the grid for emergency load. Currently, standby grid electricity from Public Service Gas and Electric can provide power for hallways and stairwell emergency lighting, elevators, and water pumps. The standby fee from the utility for the interconnect has not been an impediment to the project.

### Project at a Glance

**"People shouldn't be afraid to try CHP—it works."**
Barbara Tillman, *Grenadier Realty Corp., Managing Agent*

**Unique Characteristic:**
HUD's only CHP demonstration project

**CHP System:**
Five diesel engines, two absorption chillers, hot water hydronic heating

**Thermal Uses:**
Hydronic heating and absorption cooling for four residential towers, a grade school, pool, and commercial property

**Lesson Learned:**
One maintenance crew should take charge of all M&O

## Use of Recovered Heat

Heat is recovered from engine jackets and exhaust heat to meet 39% of the site and chiller heat demands. The CHP system provides hot water for tenants, hydronic heating with hot water, and cooling with two absorption chillers. Two supplementary boilers were installed to increase heating capacity.

*The system saves 160,000 gallons of fuel oil annually.*

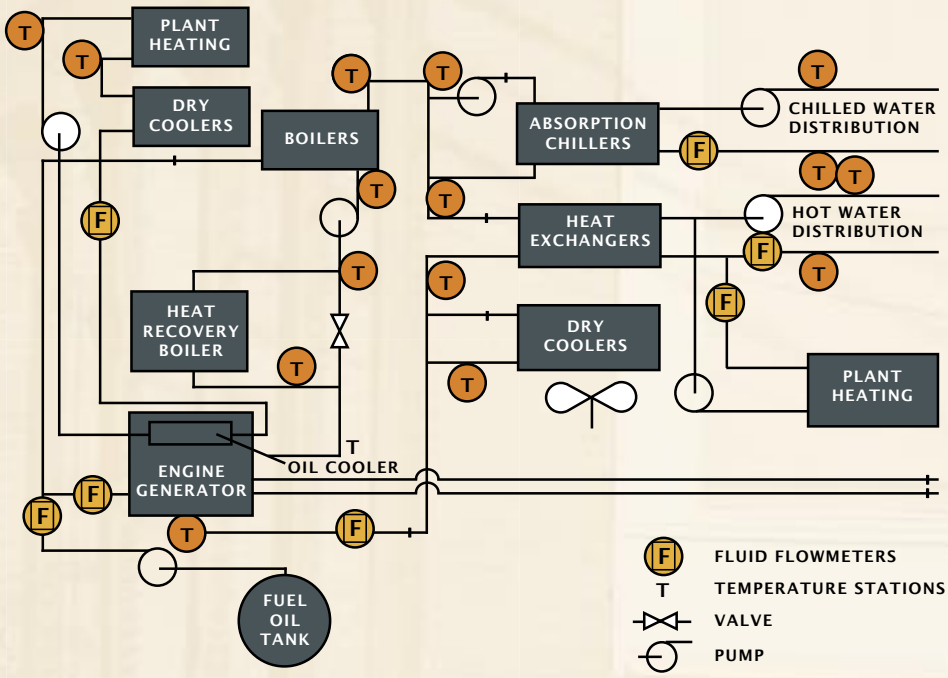
## Maintenance and Operational History

HUD's original plan called for only one person to operate and maintain the plant. The same employee also was responsible for the distribution system from the plant to the site buildings—but only to within six feet of the plant itself. Beyond six feet, the Summit Plaza maintenance staff from Grenadier Realty Corporation was responsible for all underground piping systems and the connecting building mechanical control rooms.

This arrangement turned out to be insufficient and inefficient. Grenadier recommended that it take over all maintenance duties. Four daytime staff are now working on the system, with offsite monitoring at night.

The CHP system has delivered 99.8% power reliability, although there were a few unplanned outages early in the system's history due to controls problems, equipment debugging, and a learning-curve period for plant personnel.

Grenadier has since instituted a preventive maintenance program that includes planned outages so that maintenance can be performed on the five reciprocating engines, with additional maintenance on engine controls and HVAC equipment. Such outages pose no threat to reliability since only three engines are needed under normal circumstances.




*Five diesel engines, two absorption chillers, and a hot water hydronic heating CHP system provides power, cooling, and heating for four residential towers, a grade school with heated pool, and a commercial property at Summit Plaza.*

[1] U.S. Department of Commerce, *Performance Analysis of the Jersey City Total Energy Site: Interim Report*, 1977.

[2] Ibid.

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## Costs and Benefits

### Energy

A preliminary comparative energy analysis between the CHP system and a central utility plant indicates that a central plant using purchased electricity, oil-fired boilers, and absorption chillers would have required 17.3% more fuel oil (with chillers operating in both plants at 0.6 coefficient-of-performance) than the Summit Plaza CHP system. The system saves 160,000 gallons of fuel oil annually.[3]

### Economics

Cost savings are difficult to analyze due to the complexity of HUD assistance to the housing project and to early controls and maintenance problems encountered with the project—problems which today would not have the same impact as in 1977.

### Environment

NBS assessed two environmental factors: air quality and noise level. The assessment shows that 1977 $NO_x$ levels were slightly elevated—0.03 to 0.06 ppm above background levels. Further analysis of $NO_2/NO_x$ ratios attributed some of this excess to ambient conditions. Summit Plaza property managers continue to explore ways to reduce $NO_x$ emissions.

The engine generators and exhaust fans were the predominant sources of noise pollution, but they did not exceed the 65 dB(A) set by local ordinances.

*Modern CHP technologies have much greater efficiencies and lower environmental impact than the technologies of the 1970's.*

### End-User Perspectives

Since the project began, reliability and performance of the Summit Plaza CHP system have been very good. Barbara Tillman, Managing Agent, of Grenadier Realty Corporation, reports, "If we had to do it all over again and it were up to me, I'd definitely do it. I would of course look at adding instrumentation and remote monitoring and control, and possible conversion to dual-fuel applications to take advantage of dips in natural gas or oil and hedge our fuel bets. Indeed, we've already begun a comprehensive 'Needs Assessment Study' to ensure the long-term life of the plant and explore new options and upgrades. Overall, the project has been a great success and I believe it has all the elements for replication on a grand scale. People shouldn't be afraid to try CHP—it works."

Tillman believes that a CHP power plant such as Summit Plaza's would be even more cost-effective in a larger project. For smaller properties, she believes a packaged system that could be expanded in modules would be more cost effective.

Modern CHP technologies have much greater efficiencies and lower environmental impact than the technologies of the 1970's, including advances in natural gas-fired microturbines and reciprocating engines, heat recovery steam generators, controls and communications, and selective catalytic reduction systems.

[3] U.S. Department of Commerce, *Performance Analysis of the Jersey City Total Energy Site: Executive Summary*, 1982.

# CHP Technologies in Multifamily Housing

## CHP Technologies

**Prime Movers.** Generators which can be used in CHP systems include reciprocating engines (5 kW-7 MW); microturbines (25-500 kW); combustion turbines (500 kW-25 MW); and fuel cells (1 kW-10 MW).[4] Natural gas is the cleanest and most common fuel; propane is less common, but also relatively clean. There is a growing trend toward dual-fuel systems that can combust either natural gas or diesel.

**Heat Recovery Units (HRUs).** These units capture heat from the prime mover that then can be used for heating or to drive an absorption chiller or desiccant dehumidifier.

**Absorption Chillers.** Chillers transfer recovered heat from prime movers to a heat sink through an absorbent fluid and a refrigerant. The chiller cools by absorbing and then releasing water vapor into and out of a lithium bromide solution.

*Small packaged CHP systems—such as the one shown here powered by a 60-kW microturbine—are being tested at DOE's CHP Integration Test Center at the University of Maryland. Packaged, or modular, CHP systems will be able to efficiently integrate into existing building energy systems.*

**Desiccant Dehumidifiers.** Desiccants take water out of the air by exposing a desiccant material (such as silica gel, activated alumina, lithium chloride salt, and molecular sieves) to a high relative humidity air stream—allowing it to attract and retain some of the water vapor—and then to a lower relative humidity air stream, which draws the retained moisture from the desiccant.

## Why CHP for Multifamily Housing?

**Market Potential.** Multifamily markets hold a significant potential for CHP, where electric and thermal loads are already aggregated.

- In the HUD-assisted/FHA market, there are about 7,113 properties with 20-49 units, and 15,619 properties with more than 50 units.[5]
- In the public housing market, there are about 4,535 properties with 20-49 units, and 7,154 properties with more than 50 units.[6]

**Low-Risk Market.** Multifamily housing is a relatively safe investment. A recent report from Moody's Investors Service, a leading risk analysis firm, states, "Fundamentally, multifamily is less risky than other asset types for several reasons…There is generally less cash flow volatility, they have lower operating expense ratios, they are less capital intensive than other property types, and refinance possibilities include Fannie Mae."

**Greater Control over Fuel Costs.** Natural gas price volatility and high prices have given new impetus to energy managers taking advantage of peak-shaving and lowest-cost fuel purchasing.

**Energy-Efficiency Gains.** According to DOE, CHP systems can reach efficiencies of 80%, meaning that CHP requires less fuel than conventional systems. (In comparison, utility grid electricity is approximately 33% efficient.) According to DOE, packaged or modular CHP systems integrated into commercial or multifamily properties can offer up to a 30-40 percent improvement in building efficiency over today's best practices.

**Healthier Indoor Air Quality.** In combination with a desiccant dehumidifier, CHP systems can provide better humidity control than conventional systems, and reduce the potential for mold and bacteria growth.

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[4] California Energy Commission website at: www.energy.ca.gov/distgen/equipment/equipment.html.

[5] HUD Policy Development and Research Staff, *2001 National Housing Survey*, Table 1A1.

[6] Online query, *2002 Physical Assessment Subsystem of HUD's Real Estate Assessment Center System.*

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*For more information on HUD and multifamily housing, visit www.hud.gov.*

*For more information on CHP technologies and applications, see www.eere.energy.gov/der.*